

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education
Advanced Subsidiary Examination
January 2013

Mathematics

MD01

Unit Decision 1

Friday 25 January 2013 1.30 pm to 3.00 pm

For this paper you must have:

- the blue AQA booklet of formulae and statistical tables.
- You may use a graphics calculator.

Time allowed

- 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice

- You do not necessarily need to use all the space provided.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	



J A N 1 3 M D O 1 O 1

Answer **all** questions.

Answer each question in the space provided for that question.

- 1 (a)** Draw a bipartite graph to represent the following adjacency matrix.

	1	2	3	4	5
<i>A</i>	0	0	0	0	1
<i>B</i>	0	0	0	1	1
<i>C</i>	0	1	0	1	1
<i>D</i>	0	0	0	1	1
<i>E</i>	1	1	1	0	1

(2 marks)

- (b)** If *A*, *B*, *C*, *D* and *E* represent five people and 1, 2, 3, 4 and 5 represent five tasks to which they are to be assigned, explain why a complete matching is impossible.

(2 marks)

QUESTION
PART
REFERENCE

Answer space for question 1



Answer space for question 1

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2 (a) Use a Shell sort to arrange the following numbers into ascending order.

7 8 1 6 3 4 5 2

(4 marks)

(b) Write down the number of comparisons on the first pass.

(1 mark)

QUESTION
PART
REFERENCE

Answer space for question 2

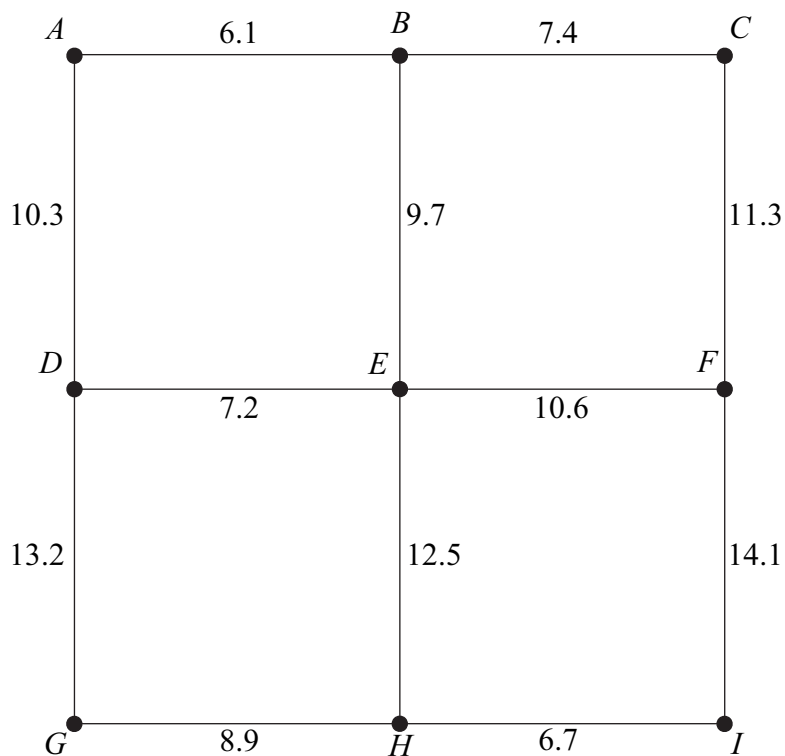


Answer space for question 2

[illegible]

- 3** The following network shows the lengths, in miles, of roads connecting nine villages, $A, B, \dots, I$.

A delivery man lives in village A and is to drive along all the roads at least once before returning to A .



Total length of all the roads is 118 miles

- (a) Find the length of an optimal Chinese postman route around the nine villages, starting and finishing at A . (5 marks)
- (b) For an optimal Chinese postman route corresponding to your answer in part (a), state:
- (i) the number of times village E would be visited;
 - (ii) the number of times village I would be visited. (2 marks)

QUESTION
PART
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Answer space for question 3

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QUESTION
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Answer space for question 3

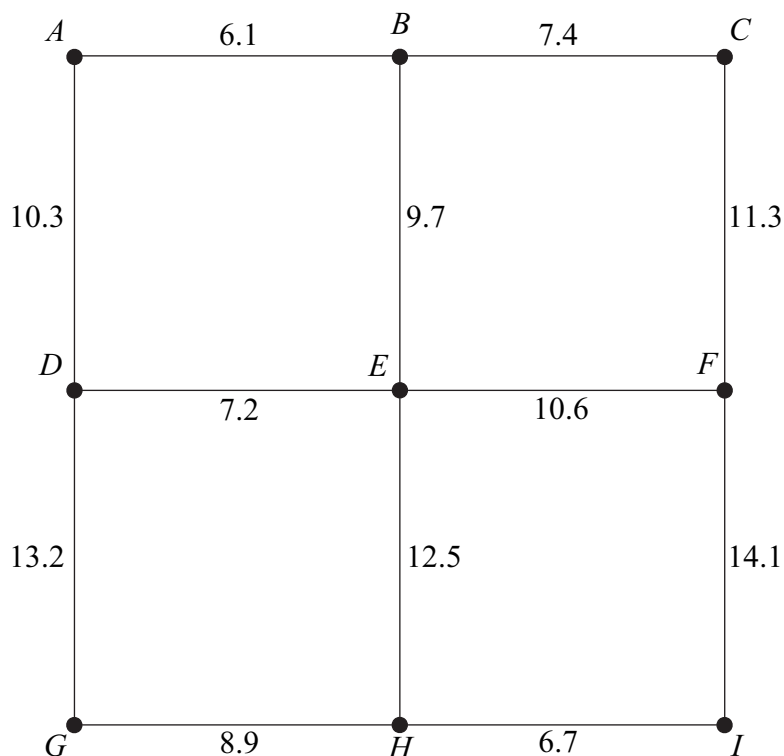
Handwriting practice area with horizontal dotted lines.

Turn over ►



- 4** The following network shows the lengths, in miles, of roads connecting nine villages, $A, B, \dots, I$.

A programme of resurfacing some roads is undertaken to ensure that each village can access all other villages along a resurfaced road, while keeping the amount of road to be resurfaced to a minimum.



- (a) (i)** Use Prim's algorithm starting from A , showing the order in which you select the edges, to find a minimum spanning tree for the network.
- (ii)** State the length of your minimum spanning tree.
- (iii)** Draw your minimum spanning tree. (7 marks)
- (b)** Given that Prim's algorithm is used with different start vertices, state the final edge to be added to the minimum spanning tree if:
- (i)** the start vertex is E ;
- (ii)** the start vertex is G . (2 marks)
- (c)** Given that Kruskal's algorithm is used to find the minimum spanning tree, state which edge would be:
- (i)** the first to be included in the tree;
- (ii)** the last to be included in the tree. (2 marks)



QUESTION
PART
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Answer space for question 4

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Answer space for question 4

[illegible]

QUESTION
PART
REFERENCE**Answer space for question 4****Turn over ►**

5 The feasible region of a linear programming problem is defined by

$$x + y \leq 60$$

$$2x + y \leq 80$$

$$y \geq 20$$

$$x \geq 15$$

$$y \geq x$$

(a) On the grid opposite, draw a suitable diagram to represent these inequalities and indicate the feasible region. (5 marks)

(b) In each of the following cases, use your diagram to find the maximum value of P on the feasible region. In each case, state the corresponding values of x and y .

(i) $P = x + 4y$ (2 marks)

(ii) $P = 4x + y$ (3 marks)

QUESTION
PART
REFERENCE

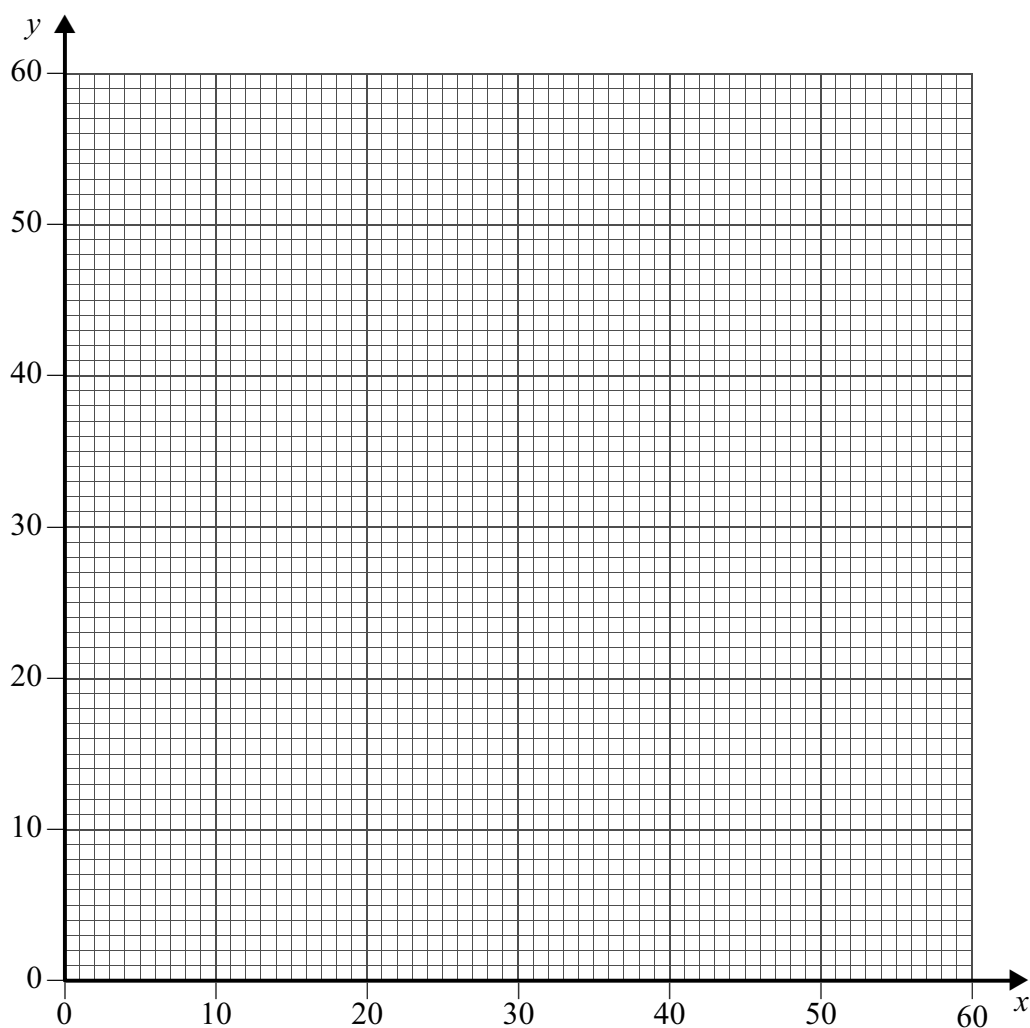
Answer space for question 5



QUESTION
PART
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Answer space for question 5

(a)



Turn over ►



- 6** The network opposite shows some roads connecting towns. The number on each edge represents the length, in miles, of the road connecting a pair of towns.
- (a) (i)** Use Dijkstra's algorithm on the network to find the minimum distance from A to J .
- (ii)** Write down the corresponding route. (7 marks)
- (b)** The road AJ is a dual carriageway. Ken drives at 60 miles per hour on this road and drives at 50 miles per hour on all other roads.
- Find the minimum time to travel from A to J . (3 marks)

QUESTION
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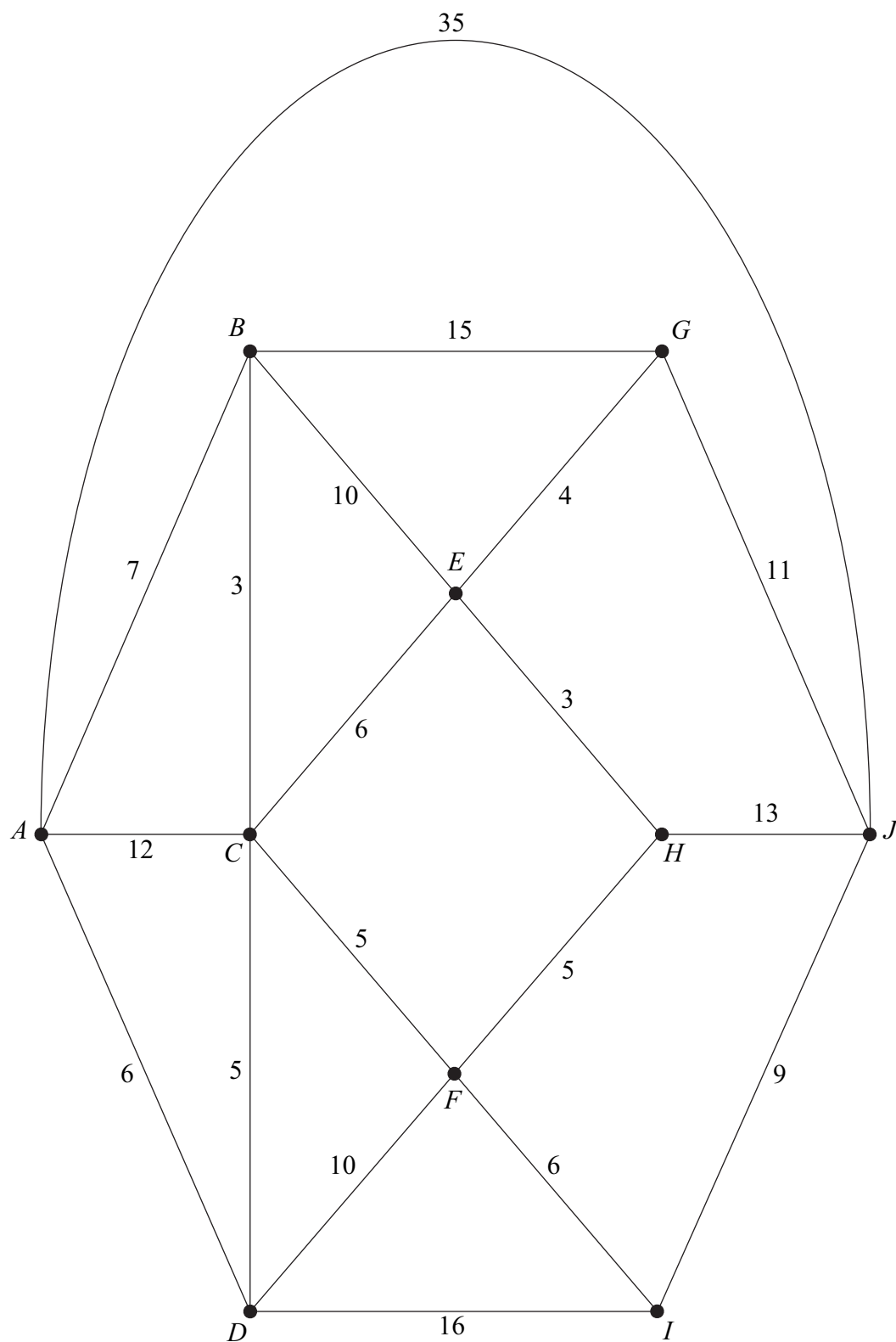
Answer space for question 6



QUESTION
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Answer space for question 6

(a)



Turn over ►



- 7 (a)** A simple connected graph X has eight vertices.
- (i) State the minimum number of edges of the graph.
 - (ii) Find the maximum number of edges of the graph. (2 marks)
- (b)** A simple connected graph Y has n vertices.
- (i) State the minimum number of edges of the graph.
 - (ii) Find the maximum number of edges of the graph. (2 marks)
- (c)** A simple graph Z has six vertices and each of the vertices has the same degree d .
- (i) State the possible values of d .
 - (ii) If Z is connected, state the possible values of d .
 - (iii) If Z is Eulerian, state the possible values of d . (4 marks)

QUESTION
PART
REFERENCE

Answer space for question 7



Answer space for question 7

[illegible]

- 8** Tony delivers paper to five offices, *A*, *B*, *C*, *D* and *E*. Tony starts his deliveries at office *E* and travels to each of the other offices once, before returning to office *E*. Tony wishes to keep his travelling time to a minimum.

The table shows the travelling times, in minutes, between the offices.

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>A</i>	–	10	16	20	8
<i>B</i>	10	–	21	15	9
<i>C</i>	16	21	–	10	23
<i>D</i>	20	15	10	–	17
<i>E</i>	8	9	23	17	–

- (a) Find the travelling time of the tour *ACDBEA*. (1 mark)
- (b) Hence write down a tour, starting at *E*, which has the same total travelling time as your answer to part (a). (1 mark)
- (c) Use the nearest neighbour algorithm, starting at *E*, to find an upper bound for the minimum travelling time for Tony's tour. (4 marks)
- (d) By deleting *E*, find a lower bound for the minimum travelling time for Tony's tour. (4 marks)
- (e) Sketch a network showing the edges that give the lower bound in part (d), and comment on its significance. (2 marks)

QUESTION
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Answer space for question 8

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Answer space for question 8

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QUESTION
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REFERENCE**Answer space for question 8****Turn over ►**

9

A factory can make three different kinds of balloon pack: gold, silver and bronze. Each pack contains three different types of balloon: A , B and C .

Each gold pack has 2 type A balloons, 3 type B balloons and 6 type C balloons.

Each silver pack has 3 type A balloons, 4 type B balloons and 2 type C balloons.

Each bronze pack has 5 type A balloons, 3 type B balloons and 2 type C balloons.

Every hour, the maximum number of each type of balloon available is 400 type A , 400 type B and 400 type C .

Every hour, the factory must pack at least 1000 balloons.

Every hour, the factory must pack more type A balloons than type B balloons.

Every hour, the factory must ensure that no more than 40% of the total balloons packed are type C balloons.

Every hour, the factory makes x gold, y silver and z bronze packs.

Formulate the above situation as 6 inequalities, in addition to $x \geq 0$, $y \geq 0$, $z \geq 0$, simplifying your answers. (8 marks)

QUESTION
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Answer space for question 9



Answer space for question 9

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QUESTION
PART
REFERENCE**Answer space for question 9****END OF QUESTIONS**

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